

**POTENTIAL  
APPLIANCE EFFICIENCY REGULATIONS  
FOR GENERAL SERVICE AND  
REFLECTOR INCANDESCENT LAMPS  
AND FOR METAL HALIDE LUMINAIRES**

**DRAFT STAFF REPORT**

October 2005  
CEC-400-2005-041-SD R  
(Revised 10/21/05)



Arnold Schwarzenegger, Governor

# CALIFORNIA ENERGY COMMISSION

Gary Flamm  
*Principal Author*

Tony Rygg  
*Project Manager*

G. William Pennington  
*Manager*  
**Buildings and Appliances  
Office**

Valerie Hall  
*Deputy Director*  
**Efficiency, Renewables and  
Demand Analysis Division**

B. B. Blevins  
*Executive Director*

## **-Disclaimer-**

This document was prepared by the staff of the California Energy Commission for public review and consideration. The conclusions and recommendations are based on information reviewed by staff and represent staff's best professional judgment, but do not necessarily represent the views of the Energy Commission. The Energy Commission has not approved or disapproved this report, nor has the Commission assessed the accuracy or adequacy of the report's information.

# Table of Contents

REVISION .....	1
BACKGROUND.....	1
DIRECTIVES TO THE ENERGY EFFICIENCY COMMITTEE .....	2
POTENTIAL STANDARDS .....	3
<i>State-Regulated General Service Incandescent Lamps</i> .....	3
<i>State-Regulated Incandescent Reflector Lamps</i> .....	11
<i>Metal Halide Luminaires</i> .....	13
TABLES	
<i>K-3 State-Regulated General Service Incandescent Lamps</i> .....	3
<i>K-4 State-Regulated Incandescent Reflector Lamps</i> .....	11
<i>N-1 Metal Halide Luminaires</i> .....	13
FIGURES	
1. <i>Frost and Clear General Service Incandescent Lamps</i> .....	7
2. <i>Soft White General Service Incandescent Lamps</i> .....	8
3. <i>Enhanced Spectrum General Service Incandescent Lamps</i> .....	9
4. <i>All Proposed Tier II Spec Lines</i> .....	10
5. <i>Analysis of Pulse Start Metal Halide Ballasts</i> .....	16

## Revision

This Draft Staff Report is a revision of, "Potential Appliance Efficiency Regulations for General Service and Reflector Incandescent Lamps and for Metal Halide Luminaires," publication number CEC-400-2005-041-SD, July 2005.

## Background

Since 1975, Section 25402 (c) of the Public Resources Code has required the California Energy Commission ("Energy Commission") to adopt standards for the energy efficiency of appliances. New and upgraded standards must be feasible and attainable, and cannot "result in any added total costs to the consumer over the designed life of the appliance." This added total cost is determined by comparing the costs and performance of a typical model with the proposed standard in effect to a typical model without the proposed standard in effect.

On December 15, 2004, the Energy Commission adopted amendments to the Energy Commission's Appliance Efficiency Regulations (California Code of Regulations, Title 20, Sections 1601-1608). The proposed amendments, known as 15 day language, were published on November 30, 2004, containing two proposals ("Alternative 1" and "Alternative 2") for provisions in 1605.3(k) (2), Table K-3 (Energy Efficiency Standards for State-Regulated General Service Incandescent Lamps), 1605 (k) (3), Table K-4 (Energy Efficiency Standards for State-Regulated Incandescent Reflector Lamps), and 1605.3 (n) (3), Table N-1 (Energy Efficiency Standards for Metal Halide Luminaires).

The Energy Commission decided to adopt Alternative 2. The adoption of Alternative 2 had broad support from affected stakeholders (they were less stringent than Alternative 1), and the Commission wanted the staff to continue working on concerns related to Alternative 1.

The 15 day language, showing Alternatives 1 and 2 for Table K-3 (Standards for State-Regulated General Service Incandescent Lamps), K-4 (Standards for State-Regulated Incandescent Reflector Lamps), and N-1 (Standards for Metal Halide Luminaires) is available on the Energy Commission website at:

<http://www.energy.ca.gov/2005publications/CEC-400-2005-012/CEC-400-2005-012.PDF>

A Committee Workshop was held on July 18, 2005 to receive public comment on potential revisions to the Regulations for incandescent lamps and metal halide luminaires that were detailed in a document titled, "Draft Staff Report; Potential Appliance Efficiency Regulations for General Service and Reflector incandescent Lamps and for Metal Halide Luminaires," dated July 2005. At that workshop, the Energy Efficiency Committee directed staff to continue working with NEMA and its

constituent members on clarifications to provisions that were adopted on December 15, 2004, to work toward reaching a consensus on the Alternative 1 provisions, and to be prepared to make decisions related to the provisions at a workshop in October 2005. This Revised Draft Staff Report contains the revised potential revisions to the Regulations for incandescent lamps and metal halide luminaires.

## **Directives to the Energy Efficiency Committee**

In the *Order Adopting Regulations and Directing Additional Rulemaking Activities* (see: [http://www.energy.ca.gov/appliances/2004rulemaking/notices/2004-12-22\\_ORDER\\_ADOPT.PDF](http://www.energy.ca.gov/appliances/2004rulemaking/notices/2004-12-22_ORDER_ADOPT.PDF) ), the Energy Commission directed the Energy Efficiency Committee to continue this rulemaking to consider possible efficiency standards for full-spectrum or enhanced spectrum general service incandescent lamps. The rulemaking also explored the possibility of making efficiency standards for general service incandescent lamps, incandescent reflector lamps, and non-vertical metal halide luminaires more stringent than those adopted in Alternative 2, and ordered appropriate action to be taken as soon as possible.

The *Order* also said, "'Alternative 1" of the 15-Day Language, which we are not adopting today, contained proposed standards for these types of equipment. Today, we are adopting Alternative 2, which eliminates some of those standards, after discussions with the National Electrical Manufacturers Association (NEMA) and several of its constituent manufacturers. One of the issues [that was] raised concerns the likely responses of consumers to (and thus the likely levels of energy savings from) standards for general service incandescent bulbs. We invite NEMA and its members to discuss actively that issue and other matters associated with the proposed lighting equipment standards listed above, including but not limited to creation, funding, and implementation of a consumer education and marketing program for energy-efficient general service incandescent lamps."

## Potential Standards

Since the December 15, 2004 adoption, the Energy Commission staff has discussed these issues with the National Electrical Manufacturers Association (NEMA) and several of its constituent members, *Flex Your Power* staff (California's statewide energy efficiency marketing and outreach campaign; see: <http://www.fypower.org/> ), and the *California Lighting Technology Center* (see: <http://cltc.ucdavis.edu/> ). A revised incandescent lamp study, *Proposed Energy Efficiency Specifications for General Service Incandescent Lamps*, has been written by Ecos Consulting, a consultant for the Pacific Gas and Electric (PG&E) Company.

This report is available on the Energy Commission web site at:  
[http://www.energy.ca.gov/appliances/lamps/documents/2005-06-22\\_PG+E\\_PROPOSED\\_INCANDESCENT.PDF](http://www.energy.ca.gov/appliances/lamps/documents/2005-06-22_PG+E_PROPOSED_INCANDESCENT.PDF)

Based on these follow-up meetings and the additional PG&E study, the Energy Efficiency Committee considered potential revisions to the Appliance Efficiency Regulations for incandescent lamps and metal halide luminaires at a Committee Workshop held on July 18, 2005. At that workshop, the Energy Efficiency Committee directed staff to continue working with NEMA and its constituent toward reaching a consensus on the Alternative 1 provisions, and to be prepared to make decisions related to the provisions at a workshop in October 2005. The following pages contain revised Alternative 1 provisions proposed by staff.

### ***Potential Standards for State-Regulated General Service Incandescent Lamps***

"Alternative 2 for Table K-3" (Energy Efficiency Standards for State-Regulated General Service Incandescent Lamps) was adopted by the Energy Commission on December 15, 2004. Alternative 2 included "Tier I" standards to be effective on January 1, 2006 for Frost or Clear and Soft White lamps. "Alternative 1 for Table K-3" was not adopted. Alternative 1 had the same requirements as Alternative 2 and in addition included standards for enhanced spectrum and vibration service lamps, and "Tier II" increased efficiency standards to be effective on January 1, 2007.

Tier 1 standards for Soft White lamps were modified and adopted by the Commission on October 19, 2005 as shown in Table K-3.

The potential standards the Efficiency Committee is considering are shown in Table K-3 on pages 4 and 5. In Table K-3, column 2 shows the standards for January 1, 2006 (Tier I) for Frost or Clear lamps as adopted by the Commission on December 15, 2004, and for Soft White lamps as adopted by the Commission on October 19, 2005. Column 3 shows the potential standards for January 1, 2008 for State-

regulated general service incandescent lamps. The standards for January 1, 2008 (Tier II) are revised from the original proposal in "Alternative 1 for Table K-3" to establish the "Maximum Allowed Wattage (W) as a Function of Lumens (L)." The Tier II standards are equations that apply to specified ranges of lumens.

***(k) Lamps (2) Standards for State-Regulated General Service Incandescent Lamps.*** *The power use of state-regulated general service incandescent lamps manufactured on or after the applicable dates shown in Table K-3 shall be no greater than the applicable values shown in Table K-3.*

**Table K-3**  
**Standards for General Service Incandescent Lamps**

<b>1</b>		<b>2</b>	<b>3</b>
<b>Lamp Type</b>		<b>Maximum Power Use (Watts)</b>	<b>Maximum Allowed Wattage (W) as a Function of Lumens (L)</b>
	<b>Lumens (L)</b>	<b>January 1, 2006</b>	<b>Potential Standards for January 1, 2008</b>
Frost or Clear	$L \leq 300$	$(0.0500 * \text{Lumens}) + 21$	$W = 0.05L + 20$
	$300 < L \leq 700$		$W = 35$
	$700 < L \leq 740$	[The standards for Frost or Clear lamps in this column were adopted by the Energy Commission on December 15, 2004.]	$W = \frac{11}{20}L - 350$
	$740 < L \leq 950$		$W = 57$
	$950 < L \leq 1020$		$W = \frac{1}{5}L - 133$
	$1020 < L \leq 1300$		$W = 71$
	$1300 < L \leq 1350$		$W = \frac{33}{100}L - 358$
	$1350 < L \leq 1500$		$W = 0.05L + 20$
	$1500 < L \leq 1850$		$W = 95$
	$1850 < L \leq 1900$		$W = \frac{2}{5}L - 645$
	$1900 < L \leq 2500$		$W = 0.05L + 20$
	$2500 < L \leq 3000$		$W = 145$
Soft White	$L \leq 270$	$(0.0500 * \text{Lumens}) + 22.5$	$W = 0.05L + 21.5$
	$270 < L \leq 670$		$W = 35$
	$670 < L \leq 725$	[The standards for Soft White lamps in this column were adopted by the Energy Commission on October 19, 2005.]	$W = \frac{2}{5}L - 233$
	$725 < L \leq 925$		$W = 57$
	$925 < L \leq 1000$		$W = \frac{7}{100}L - \frac{31}{4}$
	$1000 < L \leq 1250$		$W = 71$
	$1250 < L \leq 1300$		$W = \frac{31}{100}L - \frac{633}{2}$
	$1300 < L \leq 1470$		$W = 0.05L + 21.5$
	$1470 < L \leq 1800$		$W = 95$
	$1800 < L \leq 1850$		$W = \frac{19}{50}L - 589$
	$1850 < L \leq 2470$		$W = 0.05L + 21.5$
	$2470 < L \leq 3000$		$W = 145$



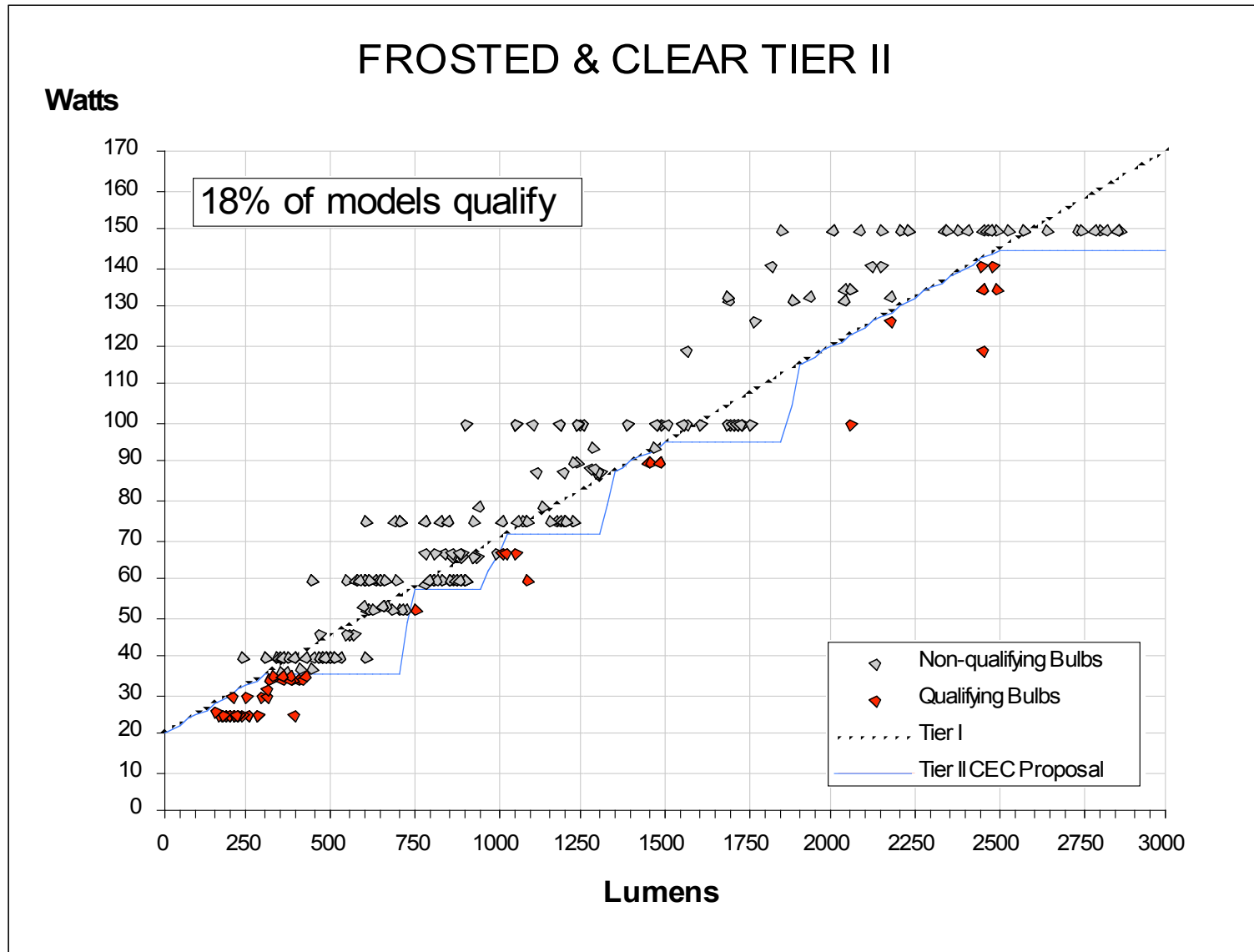
**Table K-3 (continued from previous page)**  
**Standards for General Service Incandescent Lamps**

<b>1</b>		<b>2</b>	<b>3</b>
<b>Lamp Type</b>		<b>Maximum Power Use (Watts)</b>	<b>Maximum Allowed Wattage (W) as a Function of Lumens (L)</b>
	<b>Lumens (L)</b>	<b>January 1, 2006</b>	<b>Potential Standards for January 1, 2008</b>
Enhanced Spectrum	$L \leq 270$	No Requirement	$W = 0.05L + 21.5$
	$270 < L \leq 455$		$W = 35$
	$455 < L \leq 595$		$W = \frac{4}{25}(L - 600) + 57.5$
	$600 < L \leq 695$		$W = 57$
	$695 < L \leq 790$		$W = \frac{3}{20}(L - 800) + 72.5$
	$790 < L \leq 1090$		$W = 71$
	$1090 < L \leq 1195$		$W = \frac{9}{40}(L - 1200) + 95$
	$1195 < L \leq 1450$		$W = 95$
	$1450 < L$		$W = \frac{2}{15}L - \frac{295}{3}$

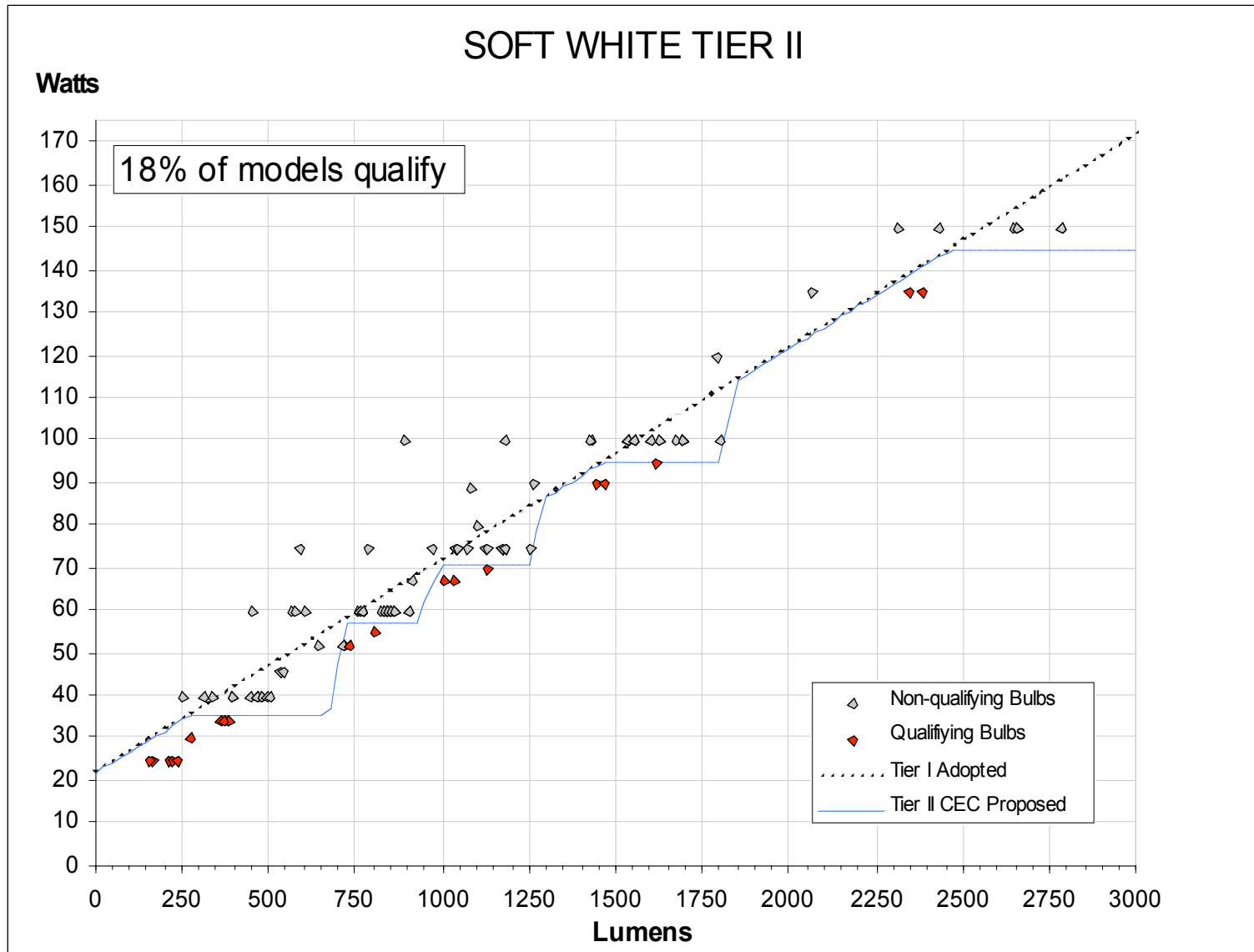
***Graphic presentations of the Table K-3 equations***

The equations for column 3 of Table K-3 are shown graphically in Figures 1 through 4 on the pages 7 through 10 of this report.

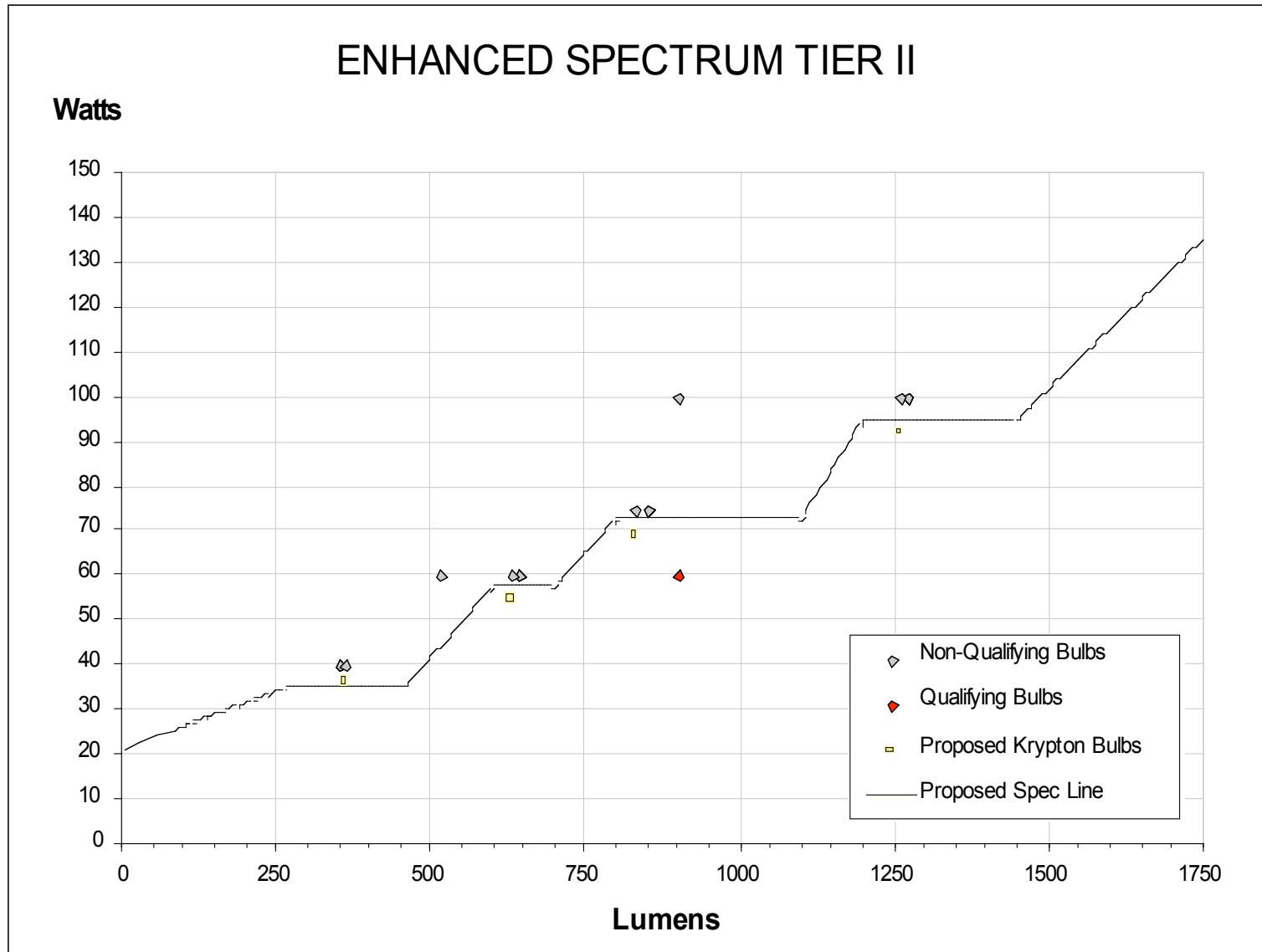
**Figure 1: Frost or Clear Bulbs**



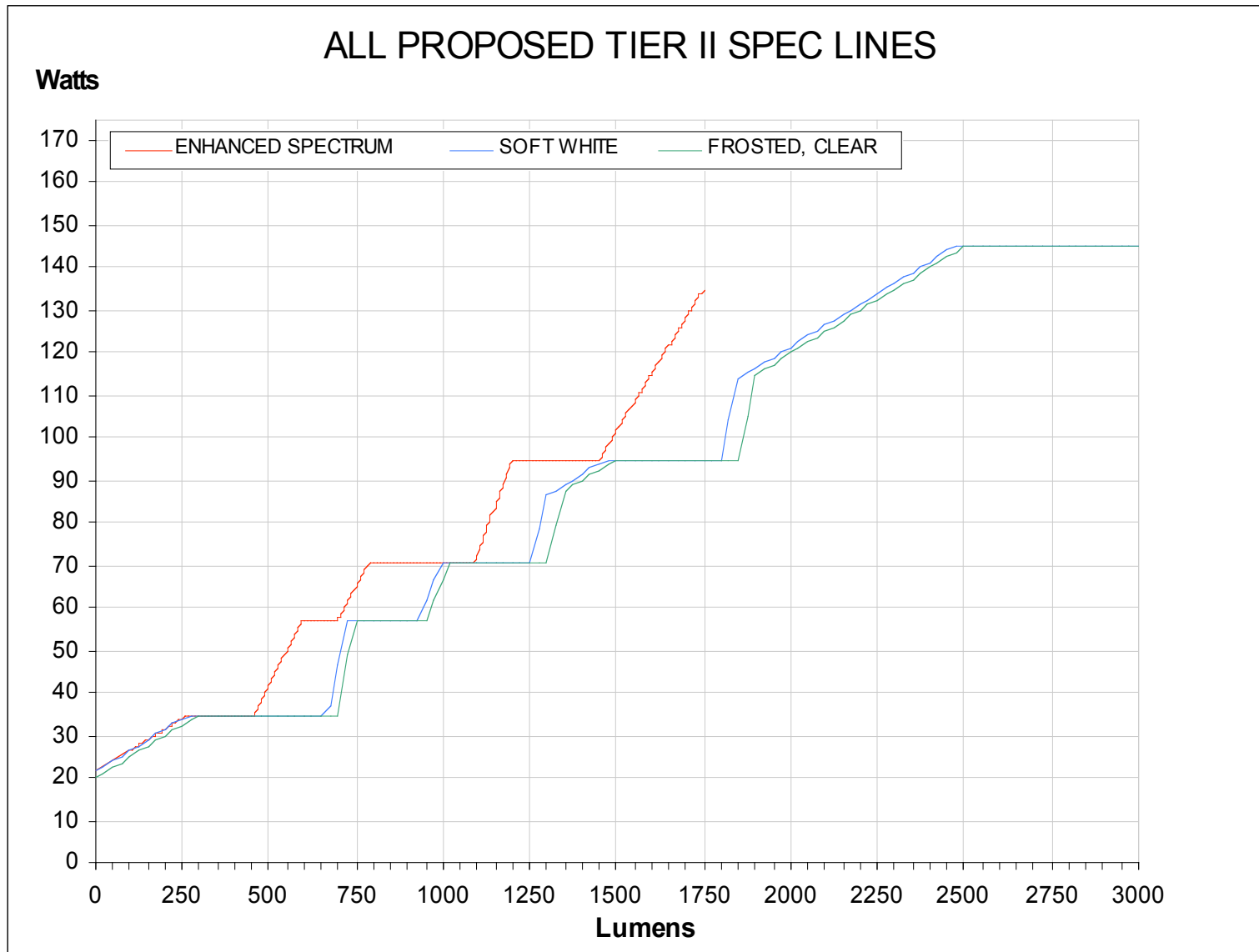
**Figure 2: Soft White Light Bulbs**



**Figure 3: Enhanced Spectrum Light Bulbs**



**Figure 4: Proposed Specification Lines in All General Service Categories**



## ***Potential Standards for State-Regulated Incandescent Reflector Lamps***

"Alternative 2 for Table K-4" (Energy Efficiency Standards for State-Regulated Incandescent Reflector Lamps) was adopted by the Energy Commission on December 15, 2004. Alternative 2 deleted Table K-4 as it was shown in Alternative 1; thus new standards were not adopted for state-regulated incandescent reflector lamps.

The potential standards the Energy Efficiency Committee is considering are shown in Table K-4 below. Table K-4 shows the standards for reflector lamps as originally proposed in "Alternative 1 for Table K-4," except for the following changes: 1) the effective date is delayed from January 1, 2006 to January 1, 2007, 2) the lowest wattage lamp in the table is changed from 40 to 41 watts, and 3) 50ER30 lamps are exempted.

***(K) Lamps (3) Standards for State-Regulated Incandescent Reflector Lamps.***  
*The average lamp efficacy of state-regulated incandescent reflector lamps manufactured on or after January 1, 2007 shall be not less than the applicable values shown in Table K-4.*

***Table K-4***  
***Standards for State-Regulated Incandescent Reflector Lamps***

<b><i>Rated Lamp Wattage</i></b>	<b><i>Minimum Average Lamp Efficacy (LPW)</i></b>
<i>40-50</i>	<i>10.5</i>
<i>51-66</i>	<i>11.0</i>
<i>67-85</i>	<i>12.5</i>
<i>86-115</i>	<i>14.0</i>
<i>116-155</i>	<i>14.5</i>
<i>156-205</i>	<i>15.0</i>

### ***LAMP EXEMPTION - Option 1***

- 50 watt ER 30 (ellipsoidal reflector, 3.75" diameter)

### **Pacific Gas and Electric Company's arguments in favor of Lamp Exemption Option 1:**

Is consistent with Standards already adopted by Washington and Oregon and therefore does not proliferate different state standards, does not reduce energy savings potential of the original Energy Commission proposal compared to Lamp Exemption Option 2 (below).

### ***LAMP EXEMPTIONS - Option 2***

- ≤ 50 watt ER 30 (ellipsoidal reflector, 3.75" diameter)
- 65 watt ER 40 (ellipsoidal reflector, 5.00" diameter)
- ≤ 50 watt ER 40 (ellipsoidal reflector, 5.00" diameter)
- 65 watt BR 30 (bulge reflector, 3.75" diameter)
- ≤ 50 watt BR 30 (bulge reflector, 3.75" diameter)
- 65 watt BR 40 (bulge reflector, 5.00" diameter)
- ≤ 50 watt BR 40 (bulge reflector, 5.00" diameter)
  
- ≤ 45 watt R 20 (reflector, 2.50" diameter)  
≤ 45 watt R 20 shall comply with Table K-4 with an effective date of January 1, 2008.

### **The National Electrical Manufacturers Association (NEMA) and American Council for an Energy-Efficient Economy (ACEEE) argument in favor of Lamp Exemptions Option 2:**

It will preserve most of the savings from the original Energy Commission proposal but substantially reduce the burden the standards provide on manufacturers.

## ***Potential Standards for Metal Halide Luminaires***

"Alternative 2 for Table N-1" (Energy Efficiency Standards for Metal Halide Luminaires) was adopted by the Energy Commission on December 15, 2004. Alternative 2 included only "Tier I" standards for metal halide luminaires designed for 150 to 500 watt vertically mounted lamps, to be effective on January 1, 2006. The Tier 1 standards for metal halide luminaires were modified to separately address base-up and base-down vertically mounted lamps, and adopted by the Energy Commission on October 19, 2005. "Alternative 1 for Table N-1" was not adopted. Alternative 1 had the same requirements as Alternative 2, and in addition included standards for metal halide luminaires designed for 150 to 500 watt horizontally mounted lamps, to be effective on January 1, 2008, and "Tier II" increased efficiency requirements for all lamp orientations, to be effective on January 1, 2008.

The potential standards the Energy Efficiency Committee is considering are shown in Table N-1 on page 12. Table N-1 shows the requirement for metal-halide luminaires that disallows probe-start ballasts for base-up vertical lamps on January 1, 2006 and all vertically mounted lamps (base-up and base-down) as adopted by the Commission on October 19, 2005. In addition Table N-1 shows the requirement that disallows probe-start ballasts for non-vertical lamps on January 1, 2008, which is the same as the original proposal in the "Alternative 1 for Table N-1." Also, the requirement for minimum lamp/ballast efficiency originally proposed in the "Alternative 1 for Table N-1" is separated into two wattage categories, with the requirement for 150-200 watts going into effect on January 1, 2008 as proposed in Alternative 1, and the requirement for 201-500 watts being delayed one year to have an effective date of January 1, 2009.

***(n)(2) Energy Efficiency Standard for Metal Halide Luminaires.*** *Metal halide luminaires, manufactured on or after the effective dates shown in Table N-1, shall meet the requirements shown in Table N-1.*



**Table N-1**  
**Standards for Metal Halide Luminaires**

<b>Lamp Position</b>	<b>Lamp Rating</b>	<b>Effective Date</b>	<b>Requirements</b>
<i>Vertical base-up</i>	<i>150-500 Watts</i>	<i>January 1, 2006</i>	<i>Luminaires shall not contain a probe-start metal halide ballast [adopted 12/15/04-modified to exclude base-down adopted on 10/19/05].</i>
<i>Vertical</i>	<i>150-500 Watts</i>	<i>January 1, 2008</i>	<i>Luminaires shall not contain a probe-start metal halide ballast [adopted 10/19/05].</i>
<i>All</i>	<i>150-500 Watts</i>	<i>January 1, 2008</i>	<i>Luminaires shall not contain a probe-start metal halide ballast.</i>
<i>All</i>	<i>150-200 Watts</i>	<i>January 1, 2008</i>	<i>Luminaires (except “exempted outdoor luminaries” and luminaries operating at 480V) shall contain a metal halide ballast with minimum ballast efficiency = <math>(0.0002 * \text{Lamp Watts}) + 0.8857</math></i>
<i>All</i>	<i>201-500 Watts</i>	<i>January 1, 2009</i>	<i>Luminaires (except “exempted outdoor luminaries” and luminaries operating at 480V) shall contain a metal halide ballast with minimum ballast efficiency = <math>(0.0001 * \text{Lamp Watts}) + 0.9019</math>.</i>

**Notes:** Fixtures are covered if they are capable of operating lamps that fall within the range of included lamp wattages. Vertical base-up includes products rated for use within 15 ° of vertical base-up. Vertical includes both base-up and base-down products. Vertical includes products rated for use within 15 ° of vertical.

### ***Graphic presentations of the Table N-1 equations***

The American Council for an Energy-Efficient Economy (ACEEE) has collected and analyzed readily available public data on a sample of electronic ballasts for pulse-start metal halide lamps including many products that have been introduced to the market since an earlier analysis was completed by them in March 2004. Data on additional products was added to the analysis and a new “best-fit” line was plotted. Figure 5 on page 16 of this report shows the results of their analysis.

The dotted black line is the best-fit line for the electronic ballasts included in their March 2004 analysis. The equation for this line is: ballast efficiency =  $(0.0002 \times \text{Lamp Watts}) + 0.8857$ .

The dashed red line represents the proposed standard based on data from our 2004 analysis. This line was developed by lowering the y-intercept of the best-fit line so that most of the electronic ballasts and a few of the best magnetic ballasts would meet or exceed the proposed standard. The y-intercept of this line is 2.5% below the y-intercept of the best-fit line; the slope remains the same. The equation for this line is: ballast efficiency =  $(0.0002 \times \text{Lamp Watts}) + 0.864$ .

The solid blue line is the best-fit line for the electronic ballasts included in our October 2005 analysis (i.e., ballasts included in the 2004 analysis plus additional data on new products). While only a few points on the graph fall below this line, some of these points account for many products. The equation for this line is: ballast efficiency =  $(0.0001 \times \text{Lamp Watts}) + 0.9019$ .

**Figure 5: 2005 Analysis of Pulse-Start Metal Halide Ballasts**

